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ORIGINAL ARTICLE

Gender-Affirming Voice Modification for Transgender Women: Characteristics and Outcomes

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Abstract

Objective: The primary aim of this study was to define characteristics of transgender women seeking gender-affirming voice modification at our voice center. The secondary aim was to evaluate outcome measures, comparing (a) behavioral voice training alone, (b) surgery alone, and (c) combination of behavioral voice training + surgery.

Methods: Patients seen in a 30-month period, who sought care for gender-affirming voice modification, were included if they were assigned male at birth and identified as female. Patient demographic information, patient quality of life index scores, Trans Woman Voice Questionnaire (TWVQ), and acoustic data were collected before and after intervention.

Results: Sixteen patients met inclusion criteria. The majority of patients were (a) undergoing hormone replacement therapy at initiation of treatment, (b) were presenting in public for over 2 years as female, and (c) had a history of psychological disorders (i.e., gender dysphoria, anxiety, depression, and attention deficit hyperactivity disorder [ADHD]). Increased f0 and decreased TWVQ scores were evident and statistically significant within behavioral voice training cohort and behavioral voice training + surgery cohort. Treatment groups appear similar with respect to average changes; pre- and post-data were not available for surgery only patients. Greater change in f0 was directly correlated with increased number of voice training sessions.

Conclusion: There is variability in treatment course for patients seeking gender-affirming voice modification; however, treatment type may not impact outcomes. Increased patient quality of life and increased speaking fundamental frequency were found in this patient cohort.

Keywords: gender-affirming voice care; KTP laser; phonosurgery; voice feminization; voice therapy; Wendler glottoplasty

Introduction

Gender affirmation is an interpersonal process in which a transgender person receives social recognition and support for their gender identity and expression.[1] This process may involve a multidisciplinary team to change various aspects of physical appearance and function to achieve congruence between gender expression and identity. Interventions for gender dysphoria as outlined by the World Professional Association for Transgender Health (WPATH), *Standards of Care*-seventh version (SOC-7),[2] include psychotherapy, hormone replacement therapy (HRT), facial feminization surgery, and gender-affirming surgery, among others. For many transgender women, a crucial part of gender affirmation is voice and communication modification.

The voice carries many aspects of identity, including gender, age, and background. Transgender women may experience gender dysphoria with their perceptual voice

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quality, vocal pitch, vocal loudness, and overall communication. Aligning voice with gender identity can be achieved by behavioral voice training, surgery, or a combination of both. Comprehensive voice care for transgender women who seek behavioral and/or medical voice modification frequently includes evaluation and intervention by laryngologists and voice-specialized speech language pathologists. Over the last two decades, there has been an effort in both of these fields to determine the most effective behavioral and surgical techniques for achieving vocal modification.

The targets of gender-affirming voice and communication training are multifaceted. For transgender women, one of the primary targets is often to increase speaking fundamental frequency (f0), as voices with a higher f0 are generally perceived as more feminine. Overviews of pitch norms suggest that voices with a fundamental frequency below 160 Hz are generally perceived as male, while those above 180 Hz are generally perceived as female; ~160 to 180 Hz are perceived as gender ambiguous.[3–6]

In addition to increasing the fundamental frequency of speech, behavioral training can also modify resonance, articulation, prosodic variation/word stress, volume, speech rate and phrasing, and language components such as word choice, as well as nonverbal communication. Behavioral gender-affirming voice training has been noted to increase f0, increase the likelihood of being auditorily perceived as female, and increase patient satisfaction with their voices.[5,7,8]

Surgical options are also available to increase the fundamental frequency by altering the length, mass, and tension of vocal cords. These properties in combination with the shape of the vocal tract correlate with f0.[9–11]

Currently, one of the preferred surgical method for most effectively increasing f0 is Wendler glottoplasty (WG), which involves endoscopic suturing of the vocal cords anteriorly to shorten their functional length.[12] Post-operative increase in f0 has been reported to change from 136 to 206 Hz after WG.[13] Another study reported a mean increase in f0 of 110 Hz after web formation assisted by temporary injection augmentation for 10 transgender women.[14] A third study observed that post-WG, 74% of patients reported voice satisfaction and 85% of patients' voices were perceived as feminine.[15]

In addition, a correlation was observed between increased f0 and being perceived as a woman over the telephone after WG.[16] Some transgender women after glottoplasty with increased f0 were still being misgendered over the telephone. This suggests a need for additional therapy in combination to surgery such as voice therapy, which can target voicing parameters beyond pitch.[16]

As health care providers, our role is to support transgender women who seek medical and/or behavioral voice modification. Further research is required not only to improve gender-affirming voice modification outcomes but also to identify other variables that may influence outcomes. Possible variables may include the number of voice training sessions, access to voice training based on location, and experience of presenting in public full time as identified gender.

The primary aim of this study was to define demographic and clinical characteristics of patients seen at our voice center for gender-affirming voice modification. The secondary aim was to evaluate outcome measures for a cohort of patients seeking congruence between communication and gender identity with: (a) behavioral voice training alone, (b) surgery alone, and a (c) combination of behavioral voice training and surgery (WG).

Methods

Study design, setting, and participants

Cleveland Clinic Institutional Review Board approval was obtained: 19-1259: Transgender Voice Treatment Outcomes. Patient consent was obtained. A retrospective cohort study was conducted[17] on all transgender women treated in The Voice Center, Head and Neck Institute at Cleveland Clinic between April 2017 and October 2019. Eighteen transgender women were seen for evaluation. One patient was excluded from this study as she opted treatment elsewhere. A second was excluded due to the complexity of her case (bilateral vocal fold atrophy, bilateral medializations using Gortex implant, and history of stroke with cognitive deficits). Therefore, 16 patients were included in this study.

Variables

Patients were separated into groups depending on treatment modality (behavioral voice training vs. surgery vs. behavioral voice training + surgery) and demographic, clinical, and outcome comparisons were drawn among these groups. Patient data were collected to define characteristics of this cohort, including (a) the number of voice training sessions completed, (b) distance travelled to attend voice training, (c) pre-treatment/post-treatment speaking f0 (Hz) and (d) pre-treatment and post-treatment scores on the Trans Woman Voice Questionnaire (TWVQ),[18] (e) HRT

status and duration, (f) duration presenting in public full time as identified gender before voice training, and (g) clinical co-morbidities.

Treatment groups were compared with regard to changes in speaking fundamental frequency and quality-of-life measures as defined by the TWVQ.

Data: sources, collection, and measurement

Transgender women seeking gender-affirming voice modification were seen for dynamic voice evaluation by a speech language pathologist to comprehensively understand each individual's vocal function, health, and acoustic parameters to appropriately guide voice modification. In addition, speech and language attributes were assessed and targeted to guide total communication. Evaluation included behavioral evaluation of voice and resonance, laryngeal function study, and videostroboscopic assessment at initial visit before initiating treatment.[19]

Patients entering the Voice Center for care were offered and all received the gold standard for voice evaluation, which includes videostroboscopic assessment and laryngeal function study.[19] Recent research found 5% of transgender women seeking voice care had abnormal findings on stroboscopy in their retrospective review.[20] This may highlight the need for instrumental assessment to fully capture any organic change to the larynx, which may have otherwise gone undetected.

Due to the length of visits and time constraints, the stroboscopic assessment and/or laryngeal function study may have been completed at second visit, but before the initiation of treatment. Videostroboscopy was used to evaluate all patients' vocal fold biomechanics at evaluation and also served as a pre-operative evaluation were they had to undergo surgery. Subjective self-assessment of the voice was determined using the TWVQ, which consists of 30 questions designed to capture the voice-related perceptions of transgender women, with scores ranging from 30 to 120.[19]

Patients were instructed in voicing tasks: (a) sustained "ah," (b) oral reading of the "rainbow passage," and (c) spontaneous speech during laryngeal function study. Their voices were recorded using an Andrea Anti-Noise NC-181 headset microphone and analyzed by the free PRAAT program to obtain fundamental frequency (Hz).[21]

Average fundamental frequency was calculated as an average between speaking fundamental frequency (sf0) during the Rainbow passage and the sf0 in conversational speech. All gender-affirming communication assessment and training were provided by two voice-specialized speech-language pathologists with training and experience with gender diverse populations.

The surgical technique WG was performed under general anesthesia by one surgeon. The purpose was to reduce the free edge of the vibrating mass of the vocal folds to increase f0 (Fig. 1).

For the procedure, a KTP laser at 30 watts, 15 mec pulse width, at 4 pulse per second was used to ablate superficial mucosa overlying the medial anterior 1/3 of bilateral true vocal folds (Fig. 2). Simple interrupted 6-0 Maxon sutures were placed through vocal ligaments to approximate the anterior 1/3 of the true vocal folds using a microflap technique (Fig. 3). A microinjection needle was inserted into the lateral anterior 1/3 region of the true vocal fold and Restylane was injected into the right and left vocal folds to medialize the true vocal folds anteriorly. Post-operative voice rest ranged from 7 to 10 days. All surgeries were completed by a single fellowship-trained laryngologist.

Patients who participated in behavioral voice training engaged in weekly or biweekly hour-long sessions. Objectives of training included the following targets: increased fundamental frequency, increased oral resonance, intonation, and acoustic assumptions using Sandy Hirsch's model, modifying vocal intensity, language/word choice, speaking rate, and non-verbal communication.[22] Self-awareness and discrimination of techniques were targeted throughout the sessions and the patients were provided with written instructions for daily home practice.

Voice training was individualized depending on baseline voice characteristics and patient-centered goals. Checklists such as the Template for Intervention Description and Replication (TIDieR)[23] checklist have

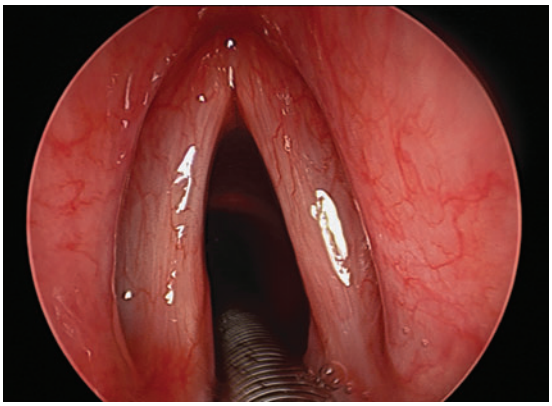

FIG. 1. Before Wendler glottoplasty.

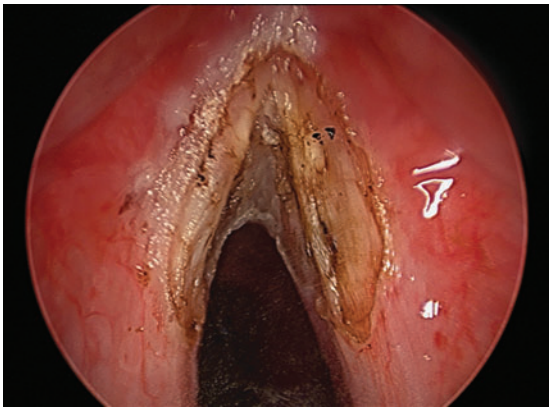

FIG. 2. After KTP ablation of the anterior commissure. KTP, potassium titanyl phosphate.

been used to describe a therapeutic intervention and define agents of change for behaviors across many disciplines. In this study, sample patient therapy targets[22,24–29] are described using the rehabilitation treatment specification system,[30] specific to communication (Table 1). Patients were treated using a variety of treatment techniques to target communication.

Study data were collected and managed using REDCap electronic data capture tools hosted at Cleveland Clinic.[31,32] REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies, providing an intuitive interface for validated data capture, audit trails for tracking data manipulation and export procedures, automated export procedures for seamless data downloads to common statistical packages, and procedures for data integration and interoperability with external sources. Two authors and one medical student retrospectively reviewed charts, which were unblinded, in the Epic electronic medical record and then recorded study data in an electronic case report form within RedCap, which were then anonymized.

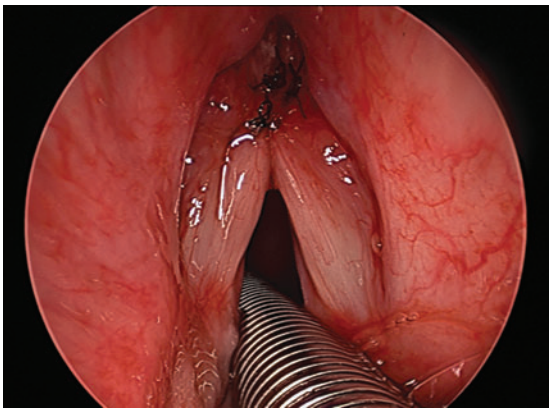

FIG. 3. Sutures at anterior commissure.

Bias

The authors would like to identify possible sources of bias. First, all personnel involved in this study are cisgendered and therefore the demographics of the population being studied are not represented among study personnel. Second, the three clinicians treating patients in the study are also authors of this article, which could potentially introduce bias.

Statistical analyses

Analysis was performed with R version 3.6.0 (www.R-project.org), a Cleveland Clinic statistician. Descriptive statistics were generated and categorical variables were summarized as frequency (%). Quantitative variables were summarized as means with corresponding standard deviations (SDs). Group comparisons with respect to categorical variables were evaluated with Fisher's exact tests. Group comparisons with respect to quantitative and ordinal variables were evaluated with *t*-tests. For quantitative variables with calculated changes, summaries of the mean values of the changes are accompanied by a *p*-value for a paired *t*-test. A p-value <0.05 was considered statistically significant.

Results

Describing the patient population

The cohort included 16 transgender women (mean age: 37.69 years and median age 36.5 years; age range: 19–62 years) undergoing different intervention modalities for voice modification. Of these 16 patients, 14 were undergoing HRT at the time of evaluation. A 19-year-old patient had not begun hormone treatment at the time of evaluation, but began it by the commencement of behavioral voice training, 2 weeks later. The second patient who was not undergoing HRT at the time of evaluation did not return for treatment.

The mean time presenting in public full time as identified gender before initial voice training was 31.72 months (range: 0–132 months). Of the concurrent co-morbidities appearing within the cohort, psychological disorders (i.e., gender dysphoria, anxiety, depression, and attention deficit hyperactivity disorder [ADHD]) occurred most frequently: 14/16 patients (87.5%) (Table 2).

Table 1. Sample Gender-Affirming Communication Training Targets Indexed by the Rehabilitation Treatment Specification System

Group	Treatment example	Selected target	Ingredient(s) for selected target	Dose for selected target	Progression for selected target
Skills and habits	Modified LMRVT[24]	Increased oral resonance Increased f0	Provides kinesthetic mapping for oral resonance and subsystem optimization (respiration/phonation resonation)	Patient executes in weekly or biweekly therapy sessions. And with home practice three to five times a day for 1 to 5 min each mini-session.	Individualized
Skills and habits	SOVT[25]	Increased oral resonance Increased f0	Using semiocclusion of the vocal tract in increase heighted interaction between source and filter to square-up vocal fold edges; allow for somatic sensation of vibration within the oral structures	Patient executes in weekly or biweekly therapy sessions. And with home practice three to five times a day for 1 to 5 min each mini-session.	Individualized
Skills and habits	CTT[26]	Conversational speech	Uses clear speech, negative practice, labeling, to facilitate ease of voicing during conversational speech	Patient executes in weekly or biweekly therapy sessions.	Individualized
Organ functions	Laryngeal manual therapy[27]	Decreased paralaryngeal muscle rigidity	Manual techniques to unload tension/rigidity of the hyolaryngeal complex	Dependent on patient need and/or patient discomfort. Clinician-provided therapy in office as needed; patient instructed in self-massage protocol from one to seven steps in length	
Skills and habits	Acoustic assumptions per Sandy Hirsch[22]	Resonance training with concurrent f0 modification with speech sounds	Teaching in individual phoneme identification of place, manner, and voicing to train and modify using concepts of source filter theory and co-articulation with resonance training	In-office direct teaching to pitfalls of each phoneme. Home practice with analysis of phrases lists.	Moving from phoneme to co-articulation with words and then phrases.
Organ functions	Vocal hygiene and wellness[28]	Increasing hydration, vocal naps, etc.	Patient motivated to maintain and/or preserve vocal health with identification of phonotraumatic or fatiguing behaviors	As needed	As needed
Representations	Self-recordings	Patients record themselves speaking and listen back	Recording device, most likely smartphone	Patient to implement during sessions for biofeedback and or at home for self-shaping of voice production	Individualized
Representations	Biofeedback with Voice Tools App[29]	Immediate feedback of vocal production	Patient programs phrases into Voice Tools and immediately can listen back, while simultaneously mapping speaking f0 or volume	As needed	Individualized

CTT, conversational training therapy; LMRVT, Lessac-Madsen Resonant Voice Therapy; SOVT, semioccluded vocal tract exercises.

Table 2. Concurrent Clinical Co-Morbidities in the Study Cohort

	N (%)
Psychological disorders	14/16 (87.5)
Neurological disorders	4/16 (25)
Voice disorders[a]	1/16 (6.25)
Head and neck cancer	0/16 (0)
Hearing loss	0/16 (0)

[a]Other than incongruence between gender identity and voice.

Patients in the voice training only cohort lived closer to Cleveland Clinic's Voice Center (average distance: 15.14 miles, SD: 9.04) compared to the combined voice training plus surgery cohort (average distance: 39.60, SD: 39.53), but a statistical comparison between these two groups was not significant ($p = 0.21$).

Other comparisons included change in average f0 (Hz) versus pre-tx average f0 (Hz) (Fig. 4), change in average f0 (Hz) versus pre-tx Transsexual Voice Questionnaire (TVQ) total (Fig. 5), change in average f0

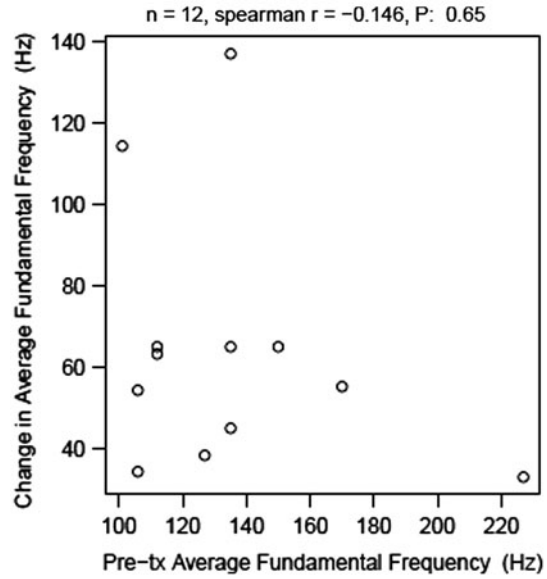

FIG. 4. Change in average fundamental frequency (Hz) versus pre-tx average fundamental frequency (Hz).

(Hz) versus pre-tx TVQ 4—"The pitch of my speaking voice is too low" (Fig. 6), change in average f0 (Hz) versus pre-tx TVQ 6—"My voice gets in the way of me living as a woman" (Fig. 7), change in average f0 (Hz) versus pre-tx age (Fig. 8), and change in average f0 (Hz) versus how long living as female before treatment? (months) (Fig. 9). None of these comparisons was statistically significant.

Outcomes by treatment type

Of the 16 patients in this study, 9 opted to engage in behavioral voice training only, 6 engaged in a combination of voice training and surgery, and only 1 pursued surgery only. For those who attended voice training, the average number of sessions attended was 10 (range 1–29 sessions). Patients who attended voice training alone and those who attended voice training plus surgery both experienced statistically and clinically significant changes in average fundamental frequency and TWVQ scores (Table 3). A decrease in TWVQ scores indicates an improvement in quality of life. Patients receiving behavioral voice training had an average increase in speaking fundamental frequency of 63.14 Hz ($p = 0.001$) and a decrease in TWVQ scores of 40.83 ($p = 0.007$).

Patients receiving behavioral voice training + surgery had an average increase of 65.20 Hz ($p = 0.025$) and an

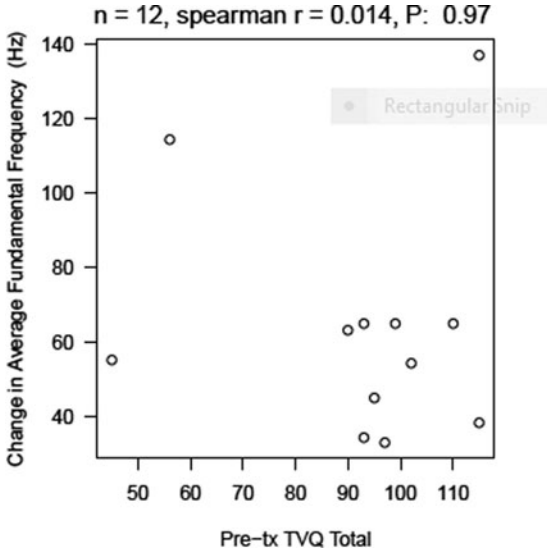

FIG. 5. Change in average fundamental frequency (Hz) versus pre-tx TVQ total. TVQ, Transsexual Voice Questionnaire.

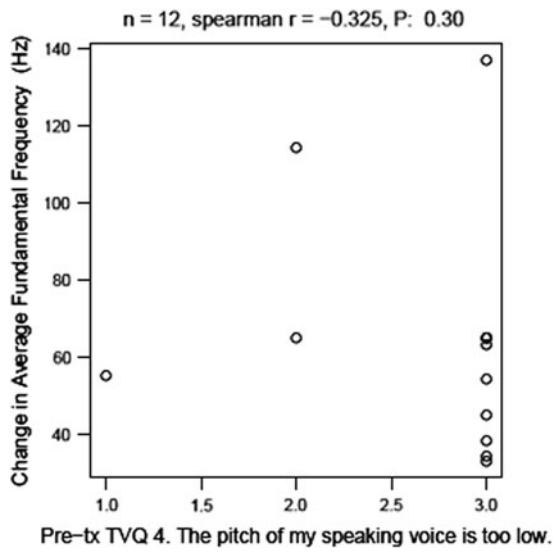

FIG. 6. Change in average fundamental frequency (Hz) versus pre-tx TVQ 4. The pitch of my speaking voice is too low.

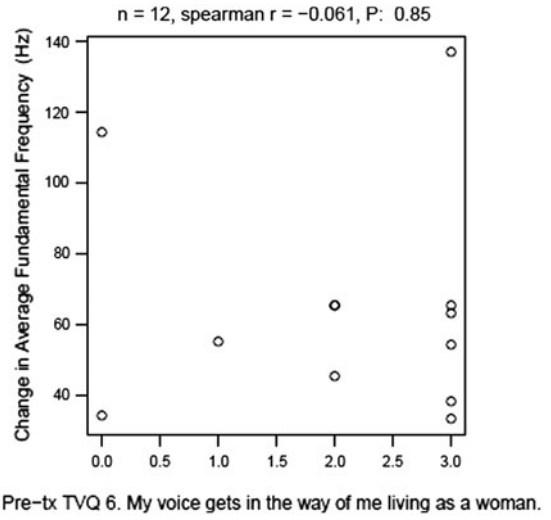

FIG. 7. Change in average fundamental frequency (Hz) versus pre-tx TVQ 6. My voice gets in the way of me living as a woman.

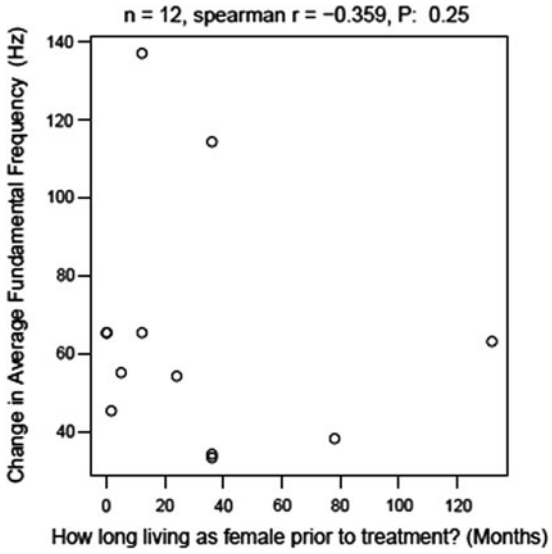

FIG. 9. Change in average fundamental frequency (Hz) versus how long living as female before treatment.

average decrease in TWVQ scores of 51.00 ($p=0.050$). However, no statistically significant difference was reported when comparing the average change for f0 ($p=0.93$) and TWVQ ($p=0.35$) between the voice training and combined voice training plus surgery groups. There was not enough data to include the surgery alone cohort. More voice training sessions were correlated with a greater increase in fundamental frequency regardless of whether the patient also had surgical intervention ($p=0.024$). Individual patient data of speaking fundamental frequency and TWVQ scores show consistent increase in f0 and decrease in TWVQ scores (Table 4).

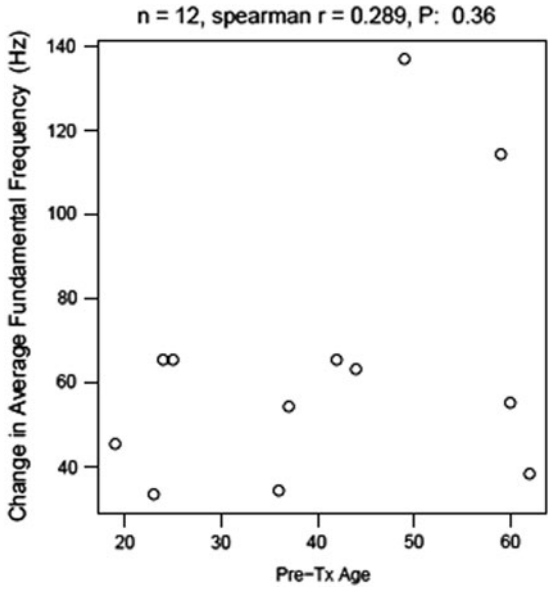

FIG. 8. Change in average fundamental frequency (Hz) versus pre-tx age.

Discussion

Our study sought to identify characteristics of transgender women seeking gender affirmation for voice modification at our Voice Center. A great majority 87.5% had co-morbid psychological disorder such gender dysphoria, anxiety, depression, and ADHD. This is in line with previous research[33] describing increased

Table 3. Change in Average Fundamental Frequency and Transsexual Voice Questionnaire Scores by Treatment Cohort

Treatment cohort	Change in average F0 (Hz) (SD)	*p*	Change in TVQ score (points) (SD)	*p*
Voice therapy	63.14 (25.50)	0.001[a]	−40.83 (22.80)	0.007[a]
Voice therapy + surgery	65.20 (41.83)	0.025[a]	−51.00 (5.66)	0.050

[a]Statistically significant = *p*-value <0.05.
SD, standard deviation; TVQ, Transsexual Voice Questionnaire.

Table 4. Individual Patient Data: Speaking Fundamental Frequency and Trans Woman Voice Questionnaire Scores

	Pre-tx/surgery		Post-tx/surgery				Change	
Subject	f0 (Hz)	TWVQ	Surgery	Tx No. Sessions	f0	TWVQ	f0 (Hz) change	TWVQ change
1	101	54	No	15	169	40	+68	−14
2	112	108	No	12	177	35	+65	−73
3	112	89	Yes—17 days post	5	169	37	+57	−52
4	135	96	No	28	200	66	+65	−30
5	135	96	No	13	180	45	+45	−51
6	106	116	Yes—41 days post	6	201	91	+95	−25
7	127	115	No	5	156	NA	+29	NA
8	227	95	No	8	260	48	+33	−47
9	135	115	Yes—23 days post	13	272	NA	+137	NA

Behavioral voice training + surgery subjects bolded. Number indicates time point data were taken after surgical intervention.
TWVQ, Trans Woman Voice Questionnaire.

risk of psychopathology and psychiatric disorders for those with gender dysphoria at the time of assessment and treatment when compared to cisgender populations. As voice and identity are intrinsically linked, it follows the self-perception of femininity would greatly be influenced by the modification of voice and communication.[34]

When investigating whether distance from our Center played a role, patients in the voice training only cohort lived closer to Cleveland Clinic's Voice Center, but this did not prove to be statically significant when comparing this distance to the behavioral voice modification + surgery cohort. However, this may bring light to access playing a role in seeking care and the necessity to offer telehealth options to patient cohorts who may have barriers to accessing health care such as distance and transportation. The small sample sizes in our groups limit the relevance of between-group comparisons.

Transgender women who seek medical and/or behavioral support in congruence between voice and gender identity have multiple options that include behavioral voice training, surgery, and combinations thereof. Currently, there is no standardized protocol for voice affirmation, as care pathways are individualized based on baseline voice characteristics and patient-centered goals.[35]

Prior research has reported that both voice training and phonosurgery represent effective strategies to increase patient satisfaction and objective metrics of voice modification such as fundamental frequency.[12] One such study[12] reported that phonosurgery techniques such as endoscopic vocal cord shortening, laser reduction glottoplasty, and cricothyroid approximation each resulted in greater desired pitch changes compared to voice training alone. In addition, the benefit of combined surgery and voice training has been substantiated by various groups. For example, it has been reported that women who received voice training support after surgery obtained significantly better scores in acoustic, perceptual, and self-reported measures of voice.[36]

In this study, patients who received both surgery and voice training did not receive a statistically significant benefit compared to patients who solely managed with voice training. However, our study did not investigate the timing of voice training in relation to surgery (e.g., before only, after only, or before and after). Furthermore, there was not enough data to investigate the outcomes of the surgery-alone treatment course compared to other care pathways.

All patients in our study were offered and received videostroboscopic assessment of vocal fold biomechanics during evaluation. Our center provides surgical gender-affirming voice care and therefore this is typically part of our evaluation. We recognize that the nature of gender-affirming voice care does not presume all patients to have a voice disorder and patients are given the option with proceeding or declining the instrumental assessment using videostroboscopy.

This study explores the possible benefits of gender affirming voice and communication training in addition to surgery utilizing a quantitative approach. In line with previous studies[37]—for our cohort—surgery combined with behavioral voice training and voice training alone represented effective modalities for gender-affirming voice modification, across two clinically approved metrics: fundamental frequency and TWVQ scores.

Positive outcomes are indicated by both increased speaking fundamental frequency to patients' speaking voice, aligned with patient-centered goals, and decreased TWVQ scores, representing patient satisfaction, which is the ultimate goal of treatment for

gender-affirming voice care. In using these as outcome variables, we also acknowledge that gender affirmation is complex and multifaceted and that these may only capture one perspective.

In a similar study, the average number of training sessions was 4.6 ± 3.9 for voice training only and 3 ± 2.9 for voice training plus WG,[37] while in our study, the average number of therapy sessions was 10 across both groups. This increase in the number of training sessions may explain the similarities in outcomes regardless of treatment type.

Our study also contributes to the existing literature by demonstrating that with each additional voice training session attended, patients received increased clinical benefit in terms of increased speaking fundamental frequency. Notably, these effects were observed for patients in both voice training and the combined surgery and voice training cohorts.

These findings highlight the importance of patient-centered care for assisting transgender women who seek behavioral and/or medical voice modification achieve voice and gender identity congruence and the important role voice-specialized speech-language pathologists play in maximizing patient success. According to the 2015 United States Transgender Survey, 14% of transgender women have undergone non-surgical voice training and another 48% would like to have it in the future.[38]

Co-morbidities (Table 2) affecting our patient cohort may have influenced which treatment type the patient chose to pursue given that the great majority of transgender women seeking voice modification had concomitant psychological disorders such as depression, anxiety, and attention-deficit hyperactivity disorder, which is consistent with known prevalence data in the literature.[39] It may follow that perhaps a surgical approach to voice training may feel invasive and increase anxiety. Conversely, if the voice is a major cause for dysphoria, perhaps a patient may seek a less-timely treatment with surgical intervention to expedite treatment.[40]

Finally, within-group changes of speaking fundamental frequency and TWVQ scores were significant, indicating that either modality for change—behavioral voice modification or behavioral voice modification plus surgery—was effective and when compared, showed no statistically significant difference. This may provide reassurance to patients that treatment modality itself will not determine voice outcomes and allow more autonomy in determining which care pathway may be best for them.

Regarding limitations, we recognize the small sample size of this study. However, it is consistent with current sample sizes in the literature when comparing voice training and phonosurgery for voice modification.[35] Furthermore, the retrospective and non-randomized nature of the study design limit the relevance of between-group comparisons. Other limitations include outcome variables that may be constrained or not representative of the patient's experience. As health care providers, our role is to utilize our expertise in voicing mechanics and physiology to collaborate with transgender, non-binary, and gender-non-conforming individuals, who seek our services in a patient centered-approach throughout their voice affirmation process.

To provide insightful guidance and informed recommendations, further research is required not only to improve treatment outcomes themselves but also to identify other variables that may influence those outcomes as well as potential disparities in accessing comprehensive care.

Furthermore, in future research for providing care for patients across the gender spectrum, it will be necessary to identify the most salient characteristics of the voice to include as outcome measures, recognizing non-binary individuals, as well. In this future research, we hope to identify outcome measures that capture a patient's gender-affirming voice modification experience in the most inclusive and patient-centered manner, as well as address any social determinant of health, which may hinder patients from accessing care, including insurance, financial means, or ability to travel.

Conclusion

This study contributes to a growing body of research regarding gender-affirming voice modification outcomes. Furthermore, it demonstrates there is a direct relationship between the number of voice training sessions and increased speaking fundamental frequency. Not surprisingly, the more voice training sessions a patient had, the greater the increase in fundamental frequency change. Therefore, when translating these data clinically, it may be useful to educate patients regarding the benefits of consistent behavioral voice training over several sessions, not only as a possible equivalent change in speaking fundamental frequency when compared to phonosurgery but also with the added benefits of work on resonance, articulation, prosodic variation, and non-verbal communication.

At present, for this patient cohort, behavioral voice training alone or voice training in combination with

WG is an equally effective voice modification modality for providing gender-affirming care for transgender women.

Authors' Contributions

Michelle Adessa, MS, CCC-SLP: conception and design of the study, drafted the proposal, obtained IRB approval, data collection, data organization and analysis, worked with statistician to obtain statistical analysis, article composition, assistance in revisions, full agreement, and accountability for all components of the study. Zoe Weston, MS, CCC-SLP: design of the study, data collection and analysis, worked with statistician to obtain statistical analysis, article composition, full agreement, and accountability for all components of the study. Jeremy Ruthberg, BA: article composition, assistance in revisions, full agreement, and accountability for all components of the study. Paul Bryson, MD: conception and design of the study, drafted the proposal, obtained IRB approval, article composition, assistance in revisions, full agreement, and accountability for all components of the study.

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Abbreviations Used

ADHD = attention deficit hyperactivity disorder
CTT = conversational training therapy
HRT = hormone replacement therapy
KTP = potassium titanyl phosphate
LMRVT = Lessac-Madsen Resonant Voice Therapy
SD = standard deviation
SOC-7 = Standards of Care-seventh version
SOVT = semioccluded vocal tract exercises
TIDieR = Template for Intervention Description and Replication
TVQ = Transsexual Voice Questionnaire
TWVQ = Trans Woman Voice Questionnaire
WG = Wendler glottoplasty
WPATH = World Professional Association for Transgender Health